SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1903.

GENERAL PHYSICS.

689. *The Bryan Planimeter.* (Engineering, 74. pp. 740 and 742–743, Dec. 5, 1902.)—This instrument is intended for evaluating the quantities of water passed through a Deacon meter or a Venturi meter, or over a weir. With an instrument such as the Deacon meter, the diagram recorded on the revolving drum is of varying scale, and an ordinary planimeter cannot be used. In order to compensate for changes of scale, Bryan arranges his roller so that the inclination of its axis to the tracing arm can be varied. The frame carrying the roller is pivoted at the one end to an arm, which is connected to the tracing arm by a universal joint. The other end of the roller frame is pressed by a spring against a cam, which cam is fixed solidly to a three-wheeled truck. Two of the three wheels of this truck run on a straight grooved rail, which thus replaces the arc of the circle, in which one end of the tracing arm of an ordinary planimeter moves. As the other end of this arm moves in or out from the guide-rail, the corresponding motion of the roller frame over the cam alters the angle between this roller and the tracing arm, and by suitably choosing the curve of the cam any given variation of scale can be compensated. The cams are arranged so as to be easily changed, and by using one with a suitable circular outline the instrument can be used as an ordinary planimeter. A sketch of the theory is given. The instrument is made by the Palatine Engineering Company, Liverpool. W. S.

690. *The United States Geological Survey Topographic Slide-Rule.* **G. H. Matthes.** (Technology Quarterly, 15. pp. 250–259, Sept., 1902.)—The author has designed this instrument with a view more particularly to the needs of the topographic branch of the United States Geological Survey; it is suited for plane table work on any scale and for any contour interval. The rule is provided with a slide and a rider, the slide bearing graduations on both faces and being reversible, while the rider is also graduated; the rule is made of German silver, is 10⅓ in. long, and weighs 11⅓ oz.; it is manufactured by Kern & Co., Aarau, Switzerland. The paper explains how to use the rule to solve the following problems: (1) Given the distance to a point in feet, to convert the same into miles, and *vice versâ*; (2) given the distance to a point in miles, required the correction for curvature and refraction, and for height of instrument; (3) given the distance to a point in miles, and the vertical angle, required the difference of elevation in feet, neglecting corrections for curvature, &c.; (4) given the stadia rod-reading in feet or in miles, and the vertical angle to a point, to find the difference of elevation in feet; (5) given the stadia rod-reading in miles and the vertical angle to a point, to find the correct horizontal distance. The precision is different for different parts of the scales, but is always greatest for cases of most frequent occurrence.

W. S.

691. *Precision Curve-Rectifier.* **L. Kleritj.** (Zeitschr. Instrumentenk. 22. pp. 311–314, Oct., 1902.)—The instrument is represented diagramatically in Fig. 1. It consists of two bars, AA_0 and DE, rigidly connected at right angles at D. From A and A_0 the two pieces Aa and A_0a_0 go down, and at a and a_0 are attached to the axles of the equal parallel wheels R and R_0; those wheels are small and sharp-rimmed. From D and E run the two pieces DC and EF; DC ends in a point at C, C being slightly above the plane through the three points B, B_0, and F on which the instrument is supported, and lying in the straight line BB_0. CF in Fig. 1 is perpendicular to BB_0. The planes of the two parallel wheels are equidistant from DC. To rectify a plane curve P_0P, the instrument is laid on the plane of the curve so that C is on P_0, and rolled along so that C remains on the curve. CF must always be tangential to the curve, and BB_0 normal. Then B and B_0 travel distances l, l' given by the rotation of the wheels, and the length of the curve P_0P is $(l + l')/2$. The mean error for circular arcs of any length is about three-fifths of a millimetre; for other curves it may be much greater. The necessary adjustments of the actual instrument are given, along with its description.

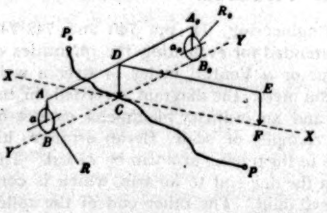

Fig. 1.

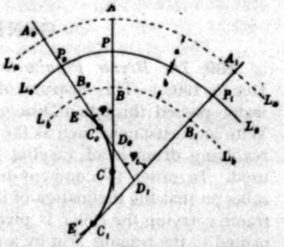

Fig. 2.

W. S.

692. *Units of Measurement.* **Fumero.** (Elettricità, Milan, 21. pp. 719–720, Nov. 9, 1902.)—Comparison of the different bases of the unitary systems —L, M, T; the systems based upon $(K\lambda) = (A/v)^2$, namely the numerical in which K, λ, A, and v have no dimensions, the electrostatic in which $(A) = (K) = 1$ and $(\lambda) = (v^{-2})$, the electromagnetic in which $(A) = (\lambda) = 1$ and $(K) = (v^{-2})$, the Hertzian in which $(K) = (\lambda) = 1$ and $(A) = (v^2)$, the four-dimensions system in which $(A) = 1$ and (K) and (λ) have no dimensions but $(K\lambda) = (1/v^2)$. The last is free from objections affecting the others; and the five-dimensions system, in which (K) and (λ) are independent dimensions, is generally considered unnecessary. There are, however, great advantages in using L, M, T and the standard ohm: (K) and (λ) then become constants of the ether, to be experimentally determined; the electric units of measure-

ment come to depend only on Time and Energy, not on Length; and they can easily be so chosen as to be independent of "absolute" measurements and of the 4π, and to be in harmony with modern electrodynamical theory and free from complications. A. D.

693. *Physical Causes of the Deviations from the Newtonian Law of Gravitation.* **P. Lebedew.** (Phys. Zeitschr. 4. pp. 15–18, Oct. 1, 1902. Report read at the Meeting of the Astronomischen Gesellschaft in Göttingen, Aug. 4, 1902.)—The author states the various explanations which have been put forward to account for the apparent repulsion of comet-tails by the sun. It is certain that the true cause must be sought for, in part, in the pressure of the light radiations emanating from the sun. Any observed deviation from the Newtonian law could take place only when the objects composing the swarm have a diameter of less than about a centimetre; if no deviation can be observed the components of the swarm must be larger than this. W. S.

694. *Determination of Linear and Angular Velocity of a Projectile at the End of its Path.* **F. Neesen.** (Deutsch. Phys. Gesell., Verh. 4. 17. pp. 380–384, Nov. 28, 1902.)—A magnesium light sends rays through an aperture in one side of the shot, which near the end of its flight is photographed simultaneously by two fixed cameras. Assuming the rotation of the shot to be unaltered during flight, the velocity can be calculated; the method can be modified so as to measure both the linear and the angular velocities. W. S.

695. *Autographic Load-Strain Recorder for Test Specimens.* **Goodman.** (Engineering, 74. pp. 805–807, Dec. 19, 1902.)—In a recorder made by Kennedy in 1885, a long steel test-bar was used as a spring, whose strain was utilised to give the load ordinate to the diagram; in the gear devised by the author the long cast-iron standard of the 100-ton Buckton testing machine at the Yorkshire College is used as a huge spring. A bar B is attached rigidly to the foot of the column and slides freely in a guide bracket C, compound levers D are attached by a knife-edge to the upper end of B, and a quadrant E is attached to the lower lever, from which the pen-carrier is suspended by a fine wire; when the machine is loaded the column shortens, due to the transverse and direct compressive stresses; but since B does not alter in length there is a relative movement which is magnified (136 times) by the lever system, thus causing the pen-carrier to rise proportional to the load on the column, and therefore to that on the test-piece. The quadrant is so arranged that the movement of the pen is strictly proportional to the load. Sticking of the pen due to friction is entirely overcome by the method originally used by Wicksteed in his autographic recorder. The strain of the specimen is transmitted to the drum by a fine wire attached to clips on the specimen itself. W. S.

696. *The Elasticity of Brittle Bodies.* **M. Grübler.** (Phys. Zeitschr. 4. 1b. p. 78, Oct. 10, 1902. Paper read before the 74 Naturforscherversammlung at Karlsbad.)—The results obtained by previous experimenters are discordant, because the theory of the strain process does not sufficiently correspond to what really goes on. The author has devised a method in which this defect is removed. A hollow circular cylinder of the substance lies between two plates, so that there is no axial stress. The stress is produced by a liquid filling the hollow space of the cylinder, and is measured by a manometer. The author has obtained consistent results from ten cement cylinders, but gives no numerical results. W. S.

697. *Experimental Determinations of Surface Tension by the Capillary Wave Method.* **L. Grunmach.** (Phys. Zeitschr. 4. 1b. pp. 26–31; Discussion, pp. 31–32, Oct. 10, 1902. Paper read before the 74 Naturforscher-versammlung at Karlsbad.)—The capillary waves were excited by means of a tuning-fork having points attached to its prongs. For pure mercury with a *fresh* surface the surface tension at 18° C. is 0·50 gramme per cm.; if the mercury surface remain in contact with the air the value falls till after from 15 to 30 minutes it reaches from 0·41 to 0·40, at which value it remains constant for a considerable time; for mercury with a large surface exposed to the atmosphere for several days, but protected against dust, the value sinks to about 0·33. For pure distilled water with perfectly fresh surface, the surface tension at 17° C. is 0·077 gramme per cm. For chemically pure absolute alcohol which had been kept out of contact with air, the surface tension for a perfectly fresh surface is 0·019 at 22·8° C.; for absolute alcohol whose free surface has been exposed to air for half an hour the value is 0·021 at 18·4° C., while after lengthened exposure the value is 0·026 at 17·7° C.; the increase with time indicates that the surface gradually absorbs moisture from the air. Values of the surface tension are given also for dilute sulphuric acid of different strengths, Russian illuminating oil and American mineral oil. W. S.

698. *Climate of Toulouse.* **B. Baillaud.** (Comptes Rendus, 135. pp. 766–768, Nov. 10, 1902.)—The fifth volume of the Annals of the Toulouse Observatory is devoted to meteorological data collated between 1868 and 1900. From these it appears that the predominating winds are south-east, west, and north-west, each of the three having about the same average frequency, and prevailing for a period equal to that representing the aggregate prevalence of the winds issuing from the other five main directions of the compass. The mean barometrical pressure per annum was found to be 45·81; the mean annual temperature 12·96 C.; the average rainfall per annum 628 mm., and the average number of rainy days 125. The author of the volume, in order to facilitate a correct appreciation of the data given, mentions that the observations were inaugurated by Frederic Petit, corresponding member of the Academy and founder of the Observatory in 1839, and continued up to the date of his death in 1866. For a few months subsequent to that date the work was continued by Despeyrons, and afterwards, until November 30, 1870, by Daguin; they were, however, not regularly published. After the latter's resignation the Observatory of Toulouse remained without a director until June 1, 1873. Thanks to the active interest taken in the matter by various members of the French Academy and by the municipality of Toulouse the management of the Observatory was in the latter year reorganised and placed under the control of Felix Tisserand, whose place was taken in 1878 by the author, and the meteorological observations were carried on from the year of Tisserand's appointment and during the directorship of the author up to the present day without interruption. Although the hours of registering the data had frequently to be altered, the alterations have caused no serious inconvenience. The instruments for automatically registering the data, employed since 1880 in the Observatory, gave very fairly accurate results for the first ten years after their installation, and have since then given the most complete satisfaction. G. G.

699. *Peculiar Hailstorm.* **A. W. G. Wilson.** (Science, 16. pp. 909–910, Dec. 5, 1902.)—The author experienced several storms in Southern Keewatin, Canada, in June and July, 1902. In the evening of July 12, many hailstones over 1·5 in. in diameter fell; the maximum dimension measured was 2¼ in. There were almost spherical pellets, ovoids, and also discs with a warty surface, produced possibly by the coalescence of independent hailstones. For about ten minutes the dense mat of *hypnum triquetrum* moss which covered the ground in the spruce forests, was seen to be in a wavy motion, although there was no wind. The undulations travelled in the direction of the storm. The author suggests that the moss, retaining the first rain, became impermeable to the air underneath and responded to the barometric variations. H. B.

REFERENCES.

700. *Graduation of Apparatus.* **Arcioni.** (Elettricità, Milan, 21. pp. 769–771, Nov. 30, 1902.)—Discussion of the considerations applicable to a convenient distribution of the graduation marks on divided scales of apparatus, taking into account the distribution of the force to be measured and that of the antagonistic force with which it comes into equilibrium. A. D.

701. *The Law of Elastic Extension.* **W. Schüle.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1512–1513, Oct. 4, 1902.)—The power law obtained experimentally by Bach has been disputed by F. Kohlrausch and Grüneisen [see Abstract No. 271 (1902)]. The author points out certain errors in the calculations of the two latter; those being corrected, Bach's power law is found to hold. W. S.

702. *Volcanic Eruptions on Martinique.* **A. Lacroix.** (Comptes Rendus, 135. pp. 672–674, Oct. 27, 1902.)—Further remarks are made [see Abstract No. 281 (1903)] emphasising the contention that the electrical phenomena, though brilliant, did not play an important part. The author is now convinced that there were no combustible gases. A small observatory has been established at an altitude of 510 m., and another was to be added. H. B.

703. *Electrical Phenomena of the Mt. Pelée Eruptions.* **B. Böhm-Raffay.** (Zeitschr. Elektrotechn., Wien, 20. pp. 437–441, Sept. 7, 1902.)—A popular account, essentially after G. Dary [see Abstract No. 13 (1903)], reproducing narrations of eyewitnesses. The author believes that electrical phenomena were chiefly responsible for the mechanical destruction and loss of life. H. B.

704. *Report of the Chief of Weather Bureau,* 1901–1902. (U.S. Weather Bureau, Bull. Parts 1 and 2, Oct. 15, 1902.)

705. *The Volcano of Mt. Pelée.* **A. Lacroix.** (Comptes Rendus, 135. pp. 771–773, Nov. 10, 1902.)—The author found in the crater a cone of rock, without central chimney, cleft to an extraordinary degree; water vapour and sulphurous acid were escaping from the clefts. This cone appeared to have been formed since August. [See also Abstract No. 281 (1903).] H. B.

706. *Solar Observations at the Lyons Observatory.* **J. Guillaume.** (Comptes Rendus, 135. pp. 887–888, Nov. 24, 1902.)—A record of the spots and faculæ observed during the third quarter of 1902. [See also Abstract No. 391 (1903).] E. C. C. B.

707. *Permanency of Planetary Atmospheres.* **S. R. Cook.** (Monthly Weather Rev. 30. pp. 401–407, Aug., 1902.)—In this paper the author gives a summary of the investigations of Johnstone Stoney, Waterston, Brian, and Rogowsky on this subject. G. W. DE T.

LIGHT.

708. *A New Stereocomparator and its Uses.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 22. pp. 65–81, March, 133–141, May, 178–192, June, and pp. 229–246, Aug., 1902. Paper read before the Naturforscherversammlung at Hamburg, Sept. 23, 1901.)—This paper describes at length the construction and uses of an instrument called by the author a stereocomparator, of which a short notice has already been published [see Abstract No. 26 (1902)]. The instrument is designed for the stereoscopic observation of two photographs which may have been taken with a stereoscopic camera at one time or else taken from two widely different standpoints, depending upon the distance of the object; in either case a true stereoscopic view may be obtained. The instrument may be made use of in surveying, in which case, for example, measurements may be made of the distance between two mountains; on the other hand, by increasing the distance between the places from which the photographs are taken, the possibility of the stereoscopic resolution of more remote objects is increased. In one case two photographs of Saturn taken with the same telescope on two consecutive nights were compared, and the planet was seen stereoscopically resolved from the fixed stars, the effect being as if an observer were looking at Saturn with his eyes 2·5 million km. apart. The author suggests the use of the instrument for the observation of stellar parallax. E. C. C. B.

709. *Mercury Surface Illuminated by Horizontal Pencil.* **G. Lippmann.** (Comptes Rendus, 135. pp. 831–832, Nov. 17, 1902.)—A mercury surface may be gauged by the reflected image of a sharp point or by placing a thin glass thread on the surface. But in cases where such devices are inapplicable one can illuminate the field of the observing instrument by a pencil of horizontal light furnished by a collimator placed on the prolongation of the lens. One then sees the mercury defined as a black region with sharp contour upon a clear under surface. The readings thus obtained agree with those by other methods where such other methods are possible. J. W. P.

710. *Stationary Light Waves.* **A. Cotton.** (Journ. de Physique, 1. pp. 689–708, Nov., 1902. Paper read before the French Society of Physics, May 2, 1902.)—The first part of the paper treats of the theory of stationary light waves as evidenced by the interference bands formed by means of a single mirror when a horizontal parallel beam of monochromatic light from a mercury arc passes through a nicol, of which the principal section is horizontal, and is reflected from a metallic mirror into a microscope. The second part details the simplest methods of reproducing the photographic experiments of Wiener and Lippmann. The film employed is a gelatine bichromate formed by dissolving 1·5 gms. of gelatine and 0·15 gms. of ammonium bichromate in 30 gms. of water. When required, this is liquefied in warm water and poured on to the glass plate through a funnel provided with a piece of absorbent cotton-wool and dried in the dark. The thickness of the film is regulated by pressing the surface against a well-polished silver mirror until, in non-actinic monochromatic light, the Newton's rings formed are of a convenient size and shape. After exposure the plate is developed by immersion in lukewarm water. It is shown that there is a close analogy between the appearance of the image, caused by breathing on the plate, and the formation of the image by means of mercury vapour in Daguerre's process. To repeat Lippmann's photography of colours, the film requires to be much thicker than in the preceding experiments. It is shown how the colours may be brought out, and an explanation of their appearance is also given. G. E. A.

711. *Interference of Light with great Path-difference.* **O. Lummer** and **E. Gehrcke.** (Deutsch. Phys. Gesell., Verh. 4. 14. pp. 337–346, Oct. 17, 1902.)—Since Fizeau and Foucault showed, in 1849, that two rays with a path-difference of 7,400 λ were in a condition to interfere, the limit has been extended by Michelson to 540,000 λ, and by Perot and Fabry to 790,000 λ. The authors describe a method, based on multiple reflection within a plane-parallel plate, by means of which interferences can be investigated for much larger path-differences. Green rays from a mercury lamp pass into a glass plate 6 cm. thick through a slit in the opaque silvering which covers the face of the plate. The opposite face is half-silvered, and the rays which emerge pass into a telescope focussed at infinity. A movable shutter at the eyepiece can cut off the rays in succession, and the change observed on cutting off the ninth reflected ray shows that the latter is still in a condition to interfere. The corresponding path-difference is 2,600,000 wave-lengths—a limit which could be extended by the use of a thicker plate. [See also Abstracts Nos. 1489 (1901) and 674 (1902).] G. E. A.

712. *Dielectric Constants of Crystals by means of Electric Waves.* **W. Schmidt.** (Ann. d. Physik, 9. 4. pp. 919–937, Nov., 1902.)—The method of Drude given in Wied. Ann. 61. pp. 466, 1897, was employed to measure the dielectric constants (K) of crystals of small size (about 1 mm. × 25 sq. mm.). The principle of the method consists in tuning a secondary circuit, containing a condenser, to a primary through which the oscillations from a Tesla transformer are passing, syntony being obtained by the usual method of varying the length of two parallel wires forming part of the secondary. The inductance is thus a measure of the reciprocal of the capacity of the condenser. The condenser plates are first immersed in standard liquids made by mixing benzol, acetone, and water in varying proportions, and a curve is drawn showing the relation between the position of the connector on the secondary and the dielectric constants of the standard liquids. With a crystal between the condenser plates a similar series of readings is next taken. Since the crystal increases the apparent value of K for some liquids and diminishes it for others, the second curve will have a different slope, and at the point where the two curves cut the value of K is the same for the crystal and a particular standard liquid.

Values of K are given, among others, for 5 regular crystals, 13 uniaxial and 12 biaxial crystals. From the results it is found: (1) That Maxwell's law, $K = \mu^2$, holds only for sulphur, never being numerically true for the other crystals. (2) The difference in K for different directions through the same crystal (electrical double refraction) is often very great (*e.g.*, about 50 per cent. in pyromorphit, rutil, and gypsum). (3) Some crystals possess remarkably high dielectric capacities along with extremely small conductivity (rutil, 173; pyromorphit, 150). (4) Comparing the author's results with those of Curie, the view of the latter is confirmed that K for calcspar, quartz, topaz, rock-salt, alum, and fluorspar is independent of the time of charging, but those for beryl and tourmaline decrease considerably as the period of oscillation increases. [See also Abstract No. 1361 (1902).] G. E. A.

713. *Temperatures of Luminous Flames.* **G. W. Stewart.** (Phys. Rev. 15. pp. 306–315, Nov., 1902.)—Kurlbaum's method has been already noticed in Abstract No. 1820 (1902). Lummer and Pringsheim have pointed out that this method is only correct on the supposition that the reflection of the flame can be neglected in comparison with the absorption. They measured the transmission of a candle flame in the red portion of the spectrum, and found it to be 80 per cent. The author, however, considers that this figure is probably much too low. In the case of acetylene flames he found that the absorption does not exceed at the most 3 or 4 per cent. He also applies the formula $\lambda_m T = A$ to luminous flames. Assuming the temperature of the acetylene flame to be 1,900° C., as found by Nichols [see Abstract No. 1625 (1900)], and the wave-length of the maximum of its energy curve to be $1{\cdot}05\ \mu$, A becomes 2,282. The wave-lengths of the maxima for the gas and candle flames are $1{\cdot}13\ \mu$ and $1{\cdot}25\ \mu$ respectively, and hence their temperatures are 1,750° C. and 1,550° C. respectively. The figure given by Kurlbaum for the temperature of the candle flame is therefore about 120° too low, and this agrees fairly well with the estimate of Lummer and Pringsheim. [See also Abstract No. 1290 (1901).] W. H. S.

714. *Action of Light on Chloride of Silver.* **C. Soret.** (Archives des Sciences, 14. pp. 560–563, Nov., 1902.)—An account of the effects obtained owing to the electromotive force produced when a surface of silver chloride is intermittently illuminated by a beam of light. The layer of silver chloride was constantly renewed, a current from one or two bichromate cells being sent between two electrodes of silver immersed in hydrochloric acid. A telephone, and when necessary a galvanometer, was placed in the circuit, and by means of a revolving disc pierced with holes an intermittent beam of light was caused to fall on the positive electrode of the voltameter. Some seconds after closing the circuit a sound is heard in the telephone, which gradually increases and becomes somewhat loud if the conditions are favourable. The positive electrode was covered by an insulating deposit except on one or two square centimetres of the surface which were strongly illuminated by an intense light, sunlight concentrated by a lens being found suitable. The alternations of the illumination must be rapid. Good results were obtained with about 650 interruptions per second. When concentrated hydrochloric acid is used the sound is much louder than with a dilute solution. Solutions of zinc chloride or sodium chloride may be used. The sound may continue a long time—for an hour or two, or more—under good conditions, but tends to fall off in the long run, probably owing to increase of the resistance. Agitation of the voltameter which has a notable influence on the strength of the current appears to be without action on the effect observed. J. J. S.

715. *The Efficiency of Photographic Shutters.* **L. Derr.** (Technology Quarterly, 15. pp. 240–249, Sept., 1902.)—Camera exposures longer than one-fifth of a second can be made by uncapping the lens, but below this limit some form of automatic shutter is necessary. In photographing objects in motion the allowable displacement of the image (generally 0·01 in.) usually limits the exposure to a very small fraction of a second; and in such cases it is a matter of considerable difficulty to get sufficient light upon the plate even under the most favourable conditions. A part of the difficulty is in the loss of light due to the action of the shutter itself. During the opening and closing periods the lens is only partly uncovered, and therefore works at a virtually smaller aperture, with corresponding loss of light. The so-called "focal plane" shutters are free from this objection, but they have the disadvantages of undesirable bulk and certain intricacies of manipulation. Shutters working at the lens may be divided into two classes. In one class the shutter-blades open and close just before or behind the diaphragm, but are entirely independent of it. In the other class, the so-called "diaphragm" shutters, the blades themselves form the diaphragm, opening only to the desired size of aperture, thus being determined by a suitable index. The efficiency of a shutter of any type may be defined as the ratio L/L′, where L is the amount of light actually admitted during exposure, and L′ the quantity which would have been admitted if the shutter had opened instantly to its full aperture, remained wide open during the entire exposure, and then closed instantly. Since this condition cannot be realised by a shutter working at the lens, it follows that the efficiency of all such apparatus is less than unity. It is certain, however, that even the best shutters sacrifice a large part of the light-gathering power of the rapid lenses now so much used. It seems, therefore, that effort should be directed towards improving the shutter rather than the lens. When experimenting as to the measurement of efficiency, the speed is sometimes determined by using the disc as a siren and comparing it with standard tuning-forks. The result obtained in this way is, however, not a trustworthy measure of the shutter speed as affecting a photograph. Every aperture will be recorded on the film; but the light through the very small apertures at the beginning and end of the exposures when the shutter is used in the regular way will be quite without effect when spread out over a plate. This method, therefore, may be expected to give speeds that are too slow. C. E. A.

716. *Lithium Spectrum.* **A. Hagenbach.** (Ann. d. Physik, 9. 4. pp. 729–741, Nov., 1902.)—The lithium spectrum differs from those of the other alkali metals in that it does not show pairs of lines; in all probability the difference in wave-length between such pairs in the lithium spectrum would be too small to permit resolution under ordinary conditions. This follows from the fact that the differences between the frequency numbers of the pairs are approximately proportional to the square roots of the atomic weights in the case of sodium, potassium, rubidium, and cæsium. The red lithium line, as obtained in the flame spectrum, at $\lambda = 6708$ was therefore examined in a Fabry and Perot's interferometer, but up to the 15,000th order of interference no doubling of the fringes could be detected; this however, may be due to the component line being extremely weak under these conditions. Photographs were then taken of the various lines by means of a Rowland grating with the arc spectrum of lithium. The line at $\lambda = 4602{\cdot}87$ ($n = 4$, first subordinate series) was strongly reversed and showed distinct doubling, two absorption lines being obtained whose wave-lengths were found to be $4603{\cdot}04 \pm 0{\cdot}014$ and $4602{\cdot}00$. It was found impossible to obtain a doubling of the same line when not reversed. An investigation of the line at $\lambda = 4972$ led the author to suspect its dual nature. The difference in wave-length between the pair at $\lambda = 4602$ was $1{\cdot}04$ A.U., the difference calculated from the proportionality to the square root of the atomic weight is $0{\cdot}87$ A.U. which shows only a rough approximation.

E. C. C. B.

717. *The Clayden Effect and the Reversal of Spectrum Lines.* **R. W. Wood.** (Phil. Mag. 4. pp. 606–607, Nov., 1902.)—Trowbridge, in photographing the spectra of powerful discharges through hydrogen, obtained certain lines reversed which he explained on the supposition of a selective reversibility of the silver salts [see Abstract No. 56 (1903)]. The author, however, attributes the phenomena entirely to the Clayden effect; in an extension of Clayden's experiments he showed that the reversing power extended throughout the entire spectrum, that is to say it was not selective. The all-important factor is the time of the light flash, so that in order to obtain the Clayden reversal it is necessary to produce a light shock of great intensity and exceeding brief duration, and then a subsequent illumination by a feebler light of longer duration [see Abstract No. 508 (1900)]. Both these conditions were probably produced in the Trowbridge experiments; the single heavy discharge gave rise to a bright line spectrum of sufficient intensity and sufficiently brief duration for the necessary light-shock, while the second condition was produced by the incandescence or phosphorescence of the glass walls of the vacuum tube. It is not difficult to understand how Trowbridge did not obtain his brightest lines reversed, because the light intensity was, no doubt in these cases, too great for the Clayden phenomenon. On these grounds, therefore, it would appear that in the case of Trowbridge's unreversed lines the necessary Clayden conditions were not realised.

E. C. C. B.

718. *Demonstration of Fluorescence.* **H. Lehmann.** (Ann. d. Physik, 9. 4. pp. 964–966, Nov., 1902.)—By employing aniline dyes, a combination of two ray filters is found such that, by looking in opposite directions through it, different colours were seen. The absorption spectrum of the combination also varies according to the direction of the light through the filter. The combination consists of two filters, of which one contains a fluorescent substance, whilst the other lets through those rays which excite fluorescence in the former. Further, the non-fluorescent filter must have an absorption band at the same place as the fluorescence spectrum of the other filter. A very efficient filter was formed by means of three colouring materials—brilliant green, rhodamin, and auramin. The green light which passes through the first filter excites orange-red fluorescence in the rhodamin; the latter colour can pass through the third filter. The combination, or a similar one, is therefore suitable for demonstrating fluorescence. G. E. A.

719. *Time Constant of Disappearance of Induced Radio-activity.* **P. Curie.** (Comptes Rendus, 135. pp. 857–859, Nov. 17, 1902.)—An enclosure contains a solid salt or a solution of a salt of radium. Solids placed in the enclosure become radio-active. If a solid thus rendered active is removed from the enclosure it loses in air its activity according to an exponential law, the radiant activity diminishing by one-half in times of the order of magnitude of half an hour. An enclosure of glass becomes active in the interior when connected by a tube with a vessel containing a salt of radium. When the enclosure is separated from the radium by sealing at the blow-pipe the communicating tube the activity of the walls of the enclosure diminishes with time according to an exponential law, but much more slowly than in the previous case. The activity decreases by one-half in four days. In the second experiment it is the radio-active air shut up in the enclosure which produces the activity of the walls. The following method of experiment was adopted. A sealed glass tube was placed in the inner cylinder of a cylindrical aluminium

condenser. The rays emitted by the tube traverse the aluminium and cause the air between the armatures of the condenser to become conducting. Measurement is made of the limiting current obtained between the two armatures when a sufficient potential difference (450 volts) is maintained between them. The radiation thus measured is due exclusively to the radio-activity of the walls, for when the radio-active air is removed rapidly from the tube the radiation measured immediately after is the same as before. The intensity of radiation I is expressed as a function of the time t by the exponential law $I = I_0 e^{-\frac{t}{\theta}}$, I_0 being the initial intensity, and θ a certain constant which represents a time. Experiments were made under very varied conditions, but all gave the same value for the time constant θ. The mean value from twenty-four series of experiments is: $\theta = 4{\cdot}970 \times 10^5$ seconds (5·752 days). According to this value of θ the radiation diminishes by one-half in 3 days 23 hours 42 minutes. The conditions of the experiment were varied in many ways, and the activity was also measured by observing the intensity of the current passing between two electrodes situated in the interior of the tube. The law of de-activation remained the same, but in the last case the conductivity measured was due both to the radio-activity of the walls and to that of the gas in the enclosure. It results from the experiments that the time constant is not influenced by the conditions of the experiment, by the nature of the gas in the enclosure, or by the matter forming the walls. The constant must then possess an importance of a general order. Each atom of radium is supposed to act as a source of energy which is dissipated by radiation or by conduction. Experiment shows that in gases the energy is stored in a special form which is dissipated according to an exponential law. It may be admitted that this energy is exhausted because it is utilised in producing the radio-activity of the gas and of the walls of the enclosure.

J. J. S.

REFERENCES.

720. *New Crystal Refractometer.* **C. Leiss.** (Zeitschr. Instrumentenk. 22. pp. 331–334, Nov., 1902.)—This is a description of an improved instrument, the use of which is based on the determination of the critical angle by means of a hemisphere of highly refractive glass. The most important improvement lies in the construction which allows measurements to be made from such small specimens as are contained in rock sections.

G. E. A.

721. *Michelson's Reference of the Metre to certain Wave-lengths of Cadmium Light.* **P. Culmann.** (Zeitschr. Instrumentenk. 22. pp. 293–311, Oct., 1902. Extract from the Bull. de la Société d'Encouragement pour l'Industrie Nationale, 101. p. 146, 1902.)—This is a description of Michelson's experiments carried out at Sèvres, in which, by an optical (interference) method, he obtained the metre in terms of certain wave-lengths of the cadmium spectrum. According to Guillaume the metre has been obtained to an accuracy of one-thousandth millimetre in terms of those wave-lengths. A fresh determination, made after the lapse of, say half a century, will test the constancy of the platinum-iridium standard metre.

W. S.

722. *Optical Glass.* **R. T. Glazebrook.** (Soc. Arts, Journ. 50. pp. 877–886, Oct. 17; 889–896, Oct. 24; 901–909, Oct. 31; and pp. 914–923, Nov. 7, 1902.)—The author discusses the problems to be solved in the construction of lenses, with special reference to the requirements of microscopic, telescopic, and photographic work. The optical properties of the various kinds of Jena glass are considered in detail.

G. W. de T.

HEAT.

723. *Low-temperature Thermostat: Comparison of Thermo-elements.* **R. Rothe.** (Zeitschr. Instrumentenk. 22. pp. 14–21, Jan., 1902; and 33–40, Feb., 1902. Communication from the Physikalisch-Technische Reichsanstalt.)—The liquid to be kept at constant temperature is contained in a cylindrical glass vessel placed inside, and separated by non-conducting material from, another glass vessel of slightly larger diameter, which is silvered both inside and out in order to diminish radiation; the latter stands on a cork inside a slightly larger cylindrical Dewar-holder with a cover of white beech, into which liquid air or solid CO_2, &c., is put, the whole being then supported inside another glass vessel. The liquid is kept well mixed by a ring-stirrer, round part of which a well-insulated wire of constantan is coiled, and it can be maintained at any uniform temperature by passing a current through this wire so as to compensate the liquid's radiation to its colder environment. There is also an arrangement for introducing some of the liquid air (if desirable) into a U-tube with closed ends which is inside the innermost vessel. By means of this thermostat thermo-elements formed of iron-constantan, copper-constantan, and platinum-platinum rhodium (10 per cent.), were examined between the temperatures 0° and —136° C.; those with constantan conform very exactly to the formula $t = ae + be^2$, where t is temperature on the air thermometer and e is the e.m.f. of the element; those with Pt, which are much less sensitive, do not. The curves drawn for the latter show a minimum value for the e.m.f. at about —142° C. R. E. B.

724. *Law of Pressure within Firearms.* **E. Vallier.** (Comptes Rendus, 135. pp. 842–845, Nov. 17, 1902.)—For the elementary pressure at time t on the base of the projectile, the author has given the formula $P_t = P_1\phi^\beta(z)$, where P_1 denotes the maximum pressure, $\phi(z) = ze^{1-z}$, $z = t/\theta$, β being an empirical coefficient, and θ the time from the beginning of motion to the instant of maximum pressure. He now establishes the relation $(\alpha - 1)\beta = 2$, where α is the "coefficient of fatigue" for the gun, and goes on to show that $\alpha + 2\gamma = 3$ for smokeless powders, γ being the mean "coefficient of combustion," or index of the power of the pressure to which the velocity of combustion is proportional. W. S.

725. *Liquid Air Apparatus.* **J. Cox.** (Canad. Elect. News, 12. pp. 191–192, Nov., 1902.)—A description is given of the Hampson liquid air plant presented by Sir W. C. Macdonald to McGill University. Air at 200 atmospheres is allowed to escape through a small aperture and is cooled on expansion. This cooled air is led back along the outside of the copper tubes through which the air is advancing to the expansion valve. The next lot of air is thus cooled before escaping, and drops to a still lower temperature on expansion. In its turn it cools the next portion of air, and when the process has gone on steadily from 6 to 10 minutes the temperature is found to have fallen below —119° C., after which a portion of the escaping air is liquefied and may be collected, about 1 litre per hour. A. D.

726. *Melting-curves of Tin Amalgams. II.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 576–591, Jan. 31, 1903.)—In a former article the author showed that, the molecular potential of tin in a liquid tin amalgam being expressed by the formula—

$$\mu_1 = f(\mathrm{T}) + \mathrm{RT}\log(1-x) + (\alpha_1 x^2 + \beta_1 x^3 + \ldots),$$

a most satisfactory accord is obtained between the values of the melting temperatures for different values of x, as calculated in this way, and the temperatures observed by van Keteren. Now, van der Waals having meanwhile drawn his attention to an excellent correction term for μ_1, viz., $\alpha_1 x^2/(1+rx)^2$, he here gives the complete deduction of this expression. The theory developed by the author affords many instances of the poly-atomicity of both mercury and tin. Accurate experiments in the direction shown by van Laar, as well as further determinations of the heats of fusion, will, however, be required, in order to arrive at a definite solution of this problem.
A. G.

727. *Folding-points in van der Waals' ψ-Surface.* **D. J. Korteweg.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 515–535, Jan. 31, 1903.)—On the outline of van der Waals' ψ-surface, there lies a folding-point only (but then always) in the case of the temperature T coinciding with the critical temperature $\mathrm{T_R}$ of the mean substance; this folding-point coincides with the critical point of the substance for which $v = 3b$. As the temperature increases, both the folding-point and the corresponding folding may behave in two wholly different ways. The various cases occurring are fully discussed, and a graphical representation is given. After setting forth some formulæ relating to existing states, the author then proceeds to considering the deformation of the ψ-surface, the spinodal line, and the connodal relations; some means of determining the folding-points are finally given. A. G.

728. *Physical Properties of Elements on van der Waals' State Equation.* **J. Traube.** (Zeitschr. Anorg. Chem. 34. 4. pp. 413–427, March 30, 1903.)—The author had shown in previous articles [Wied. Ann. 61. (1897), p. 380; and Abstracts Nos. 1906 (1901), and 2224 (1902)], that van der Waals' equation is generally applicable to the homogeneous liquid state, provided the volume of liquids be divided into the proper volume and co-volume; these quantities, as calculated by Kopp's method, proved to be in accord with the quantities b and $v - b$ of van der Waals' equation. As various reasons have of late years been suggested for molecular weights being, even in the case of solid bodies, much more simple than previously presumed, the author endeavours to extend the equation to the solid state, considering more especially the physical properties of elements from the point of view of this equation. The author accordingly calculates for a certain number of elements the constants b and a, introducing into the equation $a(v-b)/v^2 = \mathrm{RT}$, for two temperatures, the corresponding values of the volumes, the external pressure being neglected. One of these volumes was the atomic volume $\frac{\mathrm{A}}{d} = v$ at the temperature t, as calculated from the atomic weight A and density d, the second volume being next calculated by means of the coefficients of cubical expansion 3β. The values b and $v - b$ are accordingly relative to the atom, a being expressed in l-atm., and the external pressure $\mathrm{K} = \frac{a}{v^2}$ in atm. Comparing the values $v - b$ of the elements with the corresponding values of the molecular covolumes of the compounds, a characteristic difference is noted. The molecular covolumes of most of the compounds in the liquid state showed values of from 15 to 30 c.c. at 0°, whereas the covolumes of the elements both in the solid and liquid states are much smaller. The following table shows the elements arranged according to the magnitude of their atomic volumes :—

	$\frac{A}{d} = v$	$v - b$	
		Metals.	Metalloids.
Potassium	45·0	2·77	—
Bromine liquid	25·38	—	4·66
Sodium	23·58	1·22	—
Chlorine	21·35 ($d - 80°$)	—	(3·47)
Bismuth	21·27	—	0·23
Tellurium	19·84	—	0·53
Lead	18·20	0·44	—
Antimonium	17·88	—	0·19
Thallium	17·22	0·41	—
Phosphorus	16·88	—	1·38
Selenium	16·83	—	0·63
Tin	16·23	0·33	—
Sulphur	15·50	—	0·54
Mercury, liquid	14·66	(0·65)	—
Magnesium	14·00	0·31	—
Arsenium	13·09	—	0·07
Cadmium	13·02	0·31	—
Silicium	12·91	—	0·09
Aluminium	10·50	0·19	—
Silver	10·25	0·178	—
Gold	10·21	0·127	—
Palladium	9·30	0·10	—
Platinum	9·06	0·07	—
Osmium	8·51	0·046	—
Copper	7·13	0·096	—
Iron	7·12	0·070	—
Nickel	6·60	0·08	—
Graphite	5·22	—	0·037
Diamond	3·41	—	0·0047

According to Th. W. Richards, the heat Cdt communicated to an element is equivalent to the work required to overcome the internal pressure, *i.e.*, $= Kdv$. Following out this law, it is shown that—excepting carbon—the values of the internal pressure K are proportional to those calculated by the author from van der Waals' equation. Supposing the constant R to have the same value for metallic atoms both in the solid and gaseous states, it is inferred from the above that 1/3 of the heat communicated to a solid metal is used to overcome the internal pressure, 2/3 to augment the *vis viva* of the molecules. From this rule, in connection with van der Waals' equation, it follows that the coefficient of expansion of the covolume, *i.e.*, the modification of the unit of its volume, is, as a rule, a constant at equal temperatures, the value of this constant being 1/273. This relation is found to be true, excepting the halogens, both with mono-atomic metals and multi-atomic metalloids, even in the case of metals showing departures from Dulong and Petit's law, as high as those of graphite and diamond. From the equation $1/v - b \,.\, dv/dt = C/3RT$, it thus follows that the atomic heat being proportional to the constant R, may be considered as a measure of the same. It is next inferred from the above that the internal pressure being practically independent of the temperature, van der Waals' constant a will be inversely proportional to the square of the density. It is finally shown that, in heating an element, the heat is capable of altering the constant b only to a very small extent, the whole or nearly the whole of the thermal expansion of an element being thus confined to the co-volume. As regards other physical properties of elements, the author first considers the hardness and elasticity from the point of view of the state equation. It is shown from an inspection of a table where the internal pressures are given, along with the coefficients of elasticity and the hardness, that the two former constants are perfectly parallel to each other, whereas the same relation is less evident in the case of the hardness, the departures observed being most likely due to experimental difficulties. Taking the rule as true also in the case of the hardness, the coefficient of expansion of a metal must be the greater, as its melting-point is lower. It is next shown that the internal molecular (= atomic) heat of evaporation, in the case of any element, is inversely proportional to the coefficient of expansion. The absolute boiling-points of metals, as calculated from Trouton's equation, agree, in the cases considered, fairly well with the experimental values. Among other properties related to van der Waals' quantities, the author investigates the behaviour of the coefficients of compressibility, it being shown that the constant b is very much reduced by compression. As, finally, the free paths of metallic atoms, as calculated by G. Meyer, agree fairly well with those derived from van der Waals' equations, the author concludes that this equation embraces all the three states of aggregation. A. G.

729. *Theory of the Capillary Layer between Homogeneous Phases of Liquid and Vapour.* **G. Bakker.** (Zeitschr. Phys. Chem. 42. pp. 68–74, Oct., 1902.) —Introducing as this writer has done the Neumann potential $f . e^{-qr}/r$ to express the forces acting, we are no longer able to regard the capillary layer as having a definite density. The same holds for the potential V. If V be represented by the ordinate in a plane curve, and h a line at right angles to the layers be the axis of abscissæ, the curve representing V in terms of h is asymptotic to two lines parallel to h, as PϕS in the Figure. V is here supposed

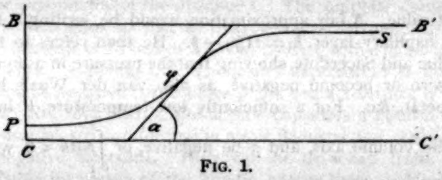

FIG. 1.

to be zero for $h = \infty$, and to be negative for finite values of h — BB′ represents the potential in homogeneous vapour. CC′ that in homogeneous liquid —the curve evidently has one point of flexure ϕ, at which $d^2V/dh^2 = 0$, and α is the angle which the tangent at ϕ makes with the h axis. The author then applies results which he has obtained in former memoirs [see Abstract No. 2138 (1900)], $1/q^2 . d^2V/dh^2 = \mu_1 - \mu$, in which μ is the thermodynamic potential of a homogeneous phase which has the density of the point in question, and μ refers to the homogeneous liquid phase. Also, v being volume and p pressure, $\mu - \mu_1 = \int_1 v dp$. He then compares these results with the theoretical isotherm HGFK, from which he shows that $\mu_1 - \mu$ becomes zero in three points H, F, K, of which H and K correspond to the infinitely distant points at which the curve PϕS in Fig. 1 touches BB′ and CC′. There remains then the point of flexure F in Fig. 2. For tan $\alpha = dV/dh$ in Fig. 1 we have [Zeitschrift Phys. Chem. 34. 175 (1900)] $1/4aq^2(dV/dh)^2 = p_1 - \theta + V^2/4a$, and we have also the fundamental equation of capillarity—

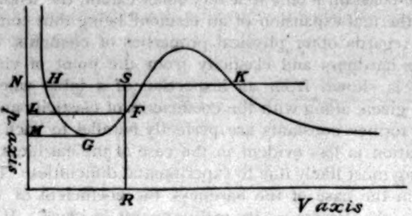

FIG. 2.

$$1/q^2 . d^2V/dh^2 = V + 2a\rho$$

[Zeitschrift Phys. Chem. 174 (1900)], in which θ denotes thermic pressure, and p the pressure in the homogeneous phase of density ρ, whence he finds that for $d^2V/dh^2 = 0$ or $V + 2a\rho = 0$, $dV/dh = 2\sqrt{2\pi f}\sqrt{p_1 - p}$ (4), and $p_1 - p$ is represented by SF in Fig. 2. It follows that if f be a constant independent of temperature l, $d \tan \alpha/dl \; a \sqrt{\mathrm{SF}}$; also SF diminishes as l increases, and in zero at the critical temperature. He proves that the value of dV/dh given in (4) is the greatest that it can have. He deduces the conclusion that in the theory of a potential $-fe^{-qr}/r$ we find for the density of the capillary layer not a definite magnitude, such for instance as a wave-length, but a practical inferior limit. If it were below that limit we should get for the capillary constant—

$$H = \frac{1}{4\pi f}\int_1^2 \left(\frac{dV}{dh}\right)^2 dh$$

an incorrect value. A fair approximation would be, writing h, for the thickness of the capillary layer, $h_1 = H/p_1 - p$. He then refers to the investigations of Leduc and Sacerdote, showing that the pressure in a liquid can attain the value zero or become negative, as also van der Waals has shown in Die Continuetät, &c. For a sufficiently low temperature, F in Fig. 2 may fall below the volume axis, and p be negative, or $\int_1^2 p_2 dh < 0$, where p_1 is the vapour pressure. This agrees with the equation $H = p_1 h_1 - \int_1^2 p_2 dh$ (15). For the temperature at which F lies on the volume axis, $h_1 = H/p_1$. In this case, therefore, h_1, the density of the capillary layer, is the ratio between the capillary pressure and the vapour pressure. S. H. B.

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ELECTRICITY AND MAGNETISM.

DISCHARGE AND OSCILLATIONS.

731. *Ionisation of Salt Flames.* **G. Moreau.** (Comptes Rendus, 135. pp. 898–900, Nov. 24, 1902.)—The author describes some experiments on the mechanism of electric conduction in flames containing the vapour of an alkaline salt solution [see Abstract No. 2250 (1902)]. The conductivity is measured by observing the current between the plates of a condenser placed in the flame and charged to a known difference of potential. The author finds that if two such condensers are placed in the flame, one above the other, the conductivity in the upper one does not change whether the lower one be charged or not, and he concludes from this that dissociation does not exist in the salt vapour before the introduction of the condensers, as the lower condenser would in such a case, when charged, absorb all the ions. If a salt flame be placed between two flames of the same dimensions as itself, but without salt vapour, and in contact with these flames, and if one pole of the condenser be fixed in one of the outer flames while the other may be moved through all three, it is found that, with a constant electric field, the conductivity suddenly increases the moment the moving pole touches the salt flame, the increase being considerable if this pole be negative, and feeble if it be positive. Thus the conductivity of a salt flame is strictly unipolar, and the ionisation is especially active round the negative pole. On studying this ionisation in the neighbourhood of the negative electrode, it is found that at a distance x from the electrode the current is expressed by the equation $I=I_0(1-e^{-kx})$, where I_0 is an increasing function of the electric field, the temperature of the electrodes, and the nature of the metal of the salt, and k is independent of the salt and the field and varies slowly with the temperature. I_0 and k do not depend on the nature of the condenser poles. From this formula we get $dI/dx=kI_0e^{-kx}$, so that the ionisation decreases according to the exponential of the distance x. The unipolar conductivity of a salt vapour is analogous to that in hydrogen gas surrounding an incandescent carbon filament or to that of a gas in contact with a metal illuminated by ultra-violet rays. Applying J. J. Thomson's explanation of these effects by the production of negative corpuscules at the contact-surface of metal and gas [see Abstract No. 1672 (1901)], the author considers it natural to suppose that these corpuscules are also formed in a salt flame at the contact with an incandescent negative electrode. They will be detached from the saline molecules probably by reason of the kinetic energy these molecules receive from the metal. A negative charge will hasten, a positive will retard the separation of these corpuscules, which, projected into the flame, ionise the salt vapour in the same manner as uranium radiation. W. C. H.

732. *Influence of Temperature on the Discharge from Points.* **E. Warburg.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 48. pp. 1062–1067, Nov. 27, 1902.)—The gases used are nitrogen and hydrogen. Their density is kept constant while the temperature is varied from 17° C. to −186° C., and the relation between current and voltage is investigated, the discharge passing from a platinum point to a surrounding cylinder. When the point is negative it is found that a lowering of the temperature produces an increase in current for

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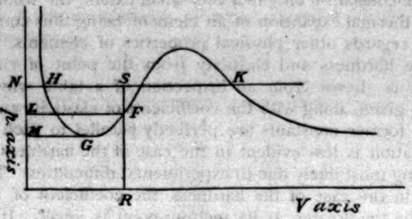

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ELECTRICAL PROPERTIES AND INSTRUMENTS.

733. *Electrical Resistance of Selenium and its Application to the Transmission of Luminous Impressions.* **Dussaud.** (Comptes Rendus, 135. pp. 790–791, Nov. 10, 1902.)—A series of coils of copper wire are imbedded in a selenium surface, and are partially short-circuited when illuminated. The increased current acts upon a relay and illuminates a glow-lamp at the receiving station. In this way, a (large) luminous image may be transmitted to a distance. T. M. L.

734. *Applicability of Wiedemann and Franz's Law to Alloys.* **F. A. Schulze.** (Ann. d. Physik, 9. 3. pp. 555–589, Oct., 1902. Habilitationsschrift.)—Few alloys have been systematically examined for the purpose of determining the ratio, conductivity for heat/conductivity for electricity, and the author has therefore studied the behaviour of zinc-tin, bismuth-lead, and bismuth-tin alloys. Assuming the law of Wiedemann and Franz to be of general applicability, it would be expected that both conductivities—thermal and electrical—would depend in the same way on the composition of the alloys; for lead-bismuth and tin-bismuth alloys this was found to be true. In both cases small additions of lead or of tin cause a rapid fall in conductivity (thermal and electrical) below that of pure bismuth; further additions of lead or of tin cause a gradual rise to the conductivity of pure lead or tin, as the case may be. The actual conductivities for heat or for electricity are always smaller than those calculated from the volume composition. For the bismuth-lead and bismuth-tin alloys, Wiedemann and Franz's law is valid just so far as it holds for pure bismuth. Zinc-tin alloys were found to possess the conductivities (electrical and thermal) calculated from the volume composition. The data given in the paper support the view that from the point of view of thermal conductivity we may divide the metals into the same two groups which a study of the electrical conductivity suggested to Matthiessen, viz., Group I., zinc, tin, lead, cadmium; Group II., all other metals. Alloys formed from metals of Group I. conduct heat according to their composition by volume, but alloys formed from metals of Group II., or from Groups I. and II., do not conduct according to their percentage composition by volume, but to a less extent. D. H. J.

735. *Ballistic Methods of Electrical Measurement.* **H. Diesselhorst.** (Ann. d. Physik, 9. 3. pp. 712–723, Oct., 1902.)—The quantity of electricity Q which passes through a ballistic galvanometer when a current of strength J is applied from the time θ to the time $\theta + \tau$, is given by the equation—

$$Q = \int_{\theta}^{\theta+\tau} J_{\theta}\, dt. \qquad \text{......................................(1)}$$

The equation of motion for the needle is—

$$K . d^2x/dt^2 + p . dx/dt + D . x = q . J_{\theta}. \qquad \text{..................(2)}$$

[See Abstract No. 570 (1903).] The solution for finding the angle of deflection x is—

$$x = \frac{\epsilon^{\mu t} - \epsilon^{\nu t}}{\mu - \nu} . v . + \frac{q}{K(\mu - \nu)} \left\{ \epsilon^{\mu t} \int_{\theta}^{t} J_{\theta} \epsilon^{-\mu t} dt - \epsilon^{\nu t} \int_{\theta}^{t} J_{\theta} \epsilon^{-\nu t} dt \right\} \text{...(3)}$$

μ and ν being the roots of the quadratic equation $K\mu^2 + p . \mu + D = 0$, and $v = dx/dt . =$ velocity of displacement. The author then proceeds to develope a relation similar to that of Dorn (Wied. Ann. 17, p. 654) for the ratio of the angular throws A, A_0 imparted to the needle by the substitution of $dx/dt = v = 0$.

$$\frac{A}{A_0} = \left(\frac{M + \eta}{1 + \eta}\right)^{\frac{\nu}{\nu - \mu}} \left(\frac{N + \eta}{1 + \eta}\right)^{\frac{\mu}{\mu - \nu}} \text{ .... (4)}$$

where—

$$M = \frac{1}{Q} \int_{\theta}^{\theta + \tau} J_{\theta} \epsilon^{-\mu t} dt ; \; N = \frac{1}{Q} \int_{\theta}^{\theta + \tau} J_{\theta} \epsilon^{-\nu t} dt ; \; \eta = \frac{K . v}{Q . q}.$$

Expanding in powers of θ and τ—

$$\frac{A}{A_0} = 1 - \tfrac{1}{2}\mu\nu(1 - \omega)[(\phi_2 - \phi_1^2) + \omega(\theta + \phi_1)^2] \text{ ....(5)}$$

or, since $\mu\nu = D/K = \pi^2/T_0^2$, where T_0 is the duration of swing in the undamped system—

$$\frac{A - A_0}{A_0} = - \frac{\pi^2(1 - \omega)}{2T_0^2}[(\phi_2 - \phi_1^2) + \omega(\theta + \phi_1)^2] \text{...............(6)}$$

where—

$$\phi_1 = \frac{\int_0^{\tau} t . J dt}{\int_0^{\tau} J dt} ; \; \phi_2 = \frac{\int_0^{\tau} t^2 . J . dt}{\int_0^{\tau} J dt} ; \; \omega = \frac{v_0}{V_0} . = \frac{\eta}{1 + \eta}.$$

If $\phi_1 = \epsilon\tau$, and $(\phi_2 - \phi_1^2) = a\tau^2$, where ϵ and a are quantities depending on the form of current used.

$$\frac{A - A_0}{A_0} = - \frac{\pi^2}{2T_0^2}(1 - \omega)[a\tau^2 + \omega(\theta + \epsilon\tau^2)] \text{...................(7)}$$

The value of $(A - A_0)/A_0$, the error due to retardation of the needle, is worked out for different current forms: (*a*) For momentary currents $(A - A_0)/A_{0_{\tau = 0}} = - \pi^2/2T_0^2 . \omega(1 - \omega)\theta^2$, *i.e.*, the error is always negative, so that the result of an acceleration or retardation of the current is that the indicated deflection on the galvanometer is too small. (*b*) For an instantaneous current with a period of duration τ, $(A - A_0)/A_{0_{\omega = 0}} = - \pi^2 a\tau^2/2T_0^2$, which shows that the error is independent of the damping. (*c*) For sine currents, *e.g.*, the earth inductor, $J = J_0 . \sin \pi t/\tau$, $\phi_1 = \frac{1}{2}\tau$, and $\phi_2 = \frac{1}{2}(1 - 4/\pi^2)\tau^2$; hence $\epsilon = \frac{1}{2}$, and $a = 1/4 - 2/\pi^2 = 0 . 04736$.

$$\therefore \quad (A - A_0)/A_0 = - 0 . 2387(1 - \omega) . \tau^2/T_0^2 - 4{\cdot}935\omega(1 - \omega)z^2/T_0^2,$$

where z is the retardation at the instant $\theta_0 = - \frac{1}{2}\tau$. (*d*) For a constant current with a period of duration τ, $\epsilon = 1/2$, and $a = 1/12$. (*e*) For a current from an induction coil, $J = J_0 . \epsilon^{-\frac{t}{\tau_0}}$, $\quad \phi_1 = \tau_0, \quad \phi_2 = 2\tau_0^2, \quad \phi_2 - \phi_1^2 = \tau_0^2$.

E. S. A. R.

736. *An Electric Quantometer.* **R. Beattie.** (Electrician, 50. pp. 383–385, Dec. 26, 1902.)—Take a moving-coil ammeter with a coil wound, as usual, on a closed metallic frame to secure electromagnetic damping, and replace the controlling springs by similar ones so weak as to produce an inappreciable control. As a result, the coil remains permanently wherever placed, and if any quantity of electricity to be measured be passed through it, it will move to another position and remain there, the angular movement being a measure of the quantity.

The author has applied this to measure the slow growth or decay of magnetism in large masses of iron following the application or suppression of a magnetising force; for leakage factor and other tests on dynamos this instrument has been found consistent and very convenient. P. E. S.

737. *Frequency Recorder.* **P. L. Mercanton.** (Journ. de Physique, 1. pp. 719–723, Nov., 1902.)—A simple form of frequency recorder suitable for frequencies up to a hundred per second is described. It is founded on the acoustic recorder of Schneebeli. A thin disc of iron is fixed in the centre of a parchment membrane which is stretched over the orifice of a wooden trumpet. An electromagnet actuated by the alternating current whose frequency is to be measured, is placed inside the tube with its face opposite the iron disc. The vibrations of the membrane are transmitted by a metal strip to a pointer which presses on a revolving drum carrying paper, coated with lampblack. On the same sheet of paper an electric tuning-fork records its vibrations, thus making it a chronograph. The traces made on the paper can be fixed by alcohol and studied at any time. The diagrams given of records made by this instrument show that it can be used to measure a frequency of a hundred per second with an accuracy of about 0·2 per cent. A. R.

738. *Rayleigh's Alternate Current Phasemeter.* **E. S. Johonnott.** (Phys. Rev. 15. pp. 276–290, Nov., 1902.)—The author shows the extended application of this instrument to the measurement of current and e.m.f., and thus the apparent watts, true watts, power-factor, hysteresis, &c., may be obtained by proper calibration. In order to determine the angle of lag, readings are taken with the currents in the current coil M, and shunt coil S. The formula used is—

$$\text{Cos}\,\phi = \frac{C_1^2 - A^2 - B^2}{2AB} = \frac{A^2 + B^2 - C_2^2}{2AB} = \frac{C_1^2 - C_2^2}{4AB}.$$

where A^2 and B^2 are proportional to the mean square values of the currents in M and S acting independently; C_1^2 and C_2^2 are proportional to the currents when the coils are acting simultaneously on the needle, firstly when in the same direction, and secondly in opposite directions. The equation $C_1^2 + C_2^2 = 2(A^2 + B^2)$ is useful in adjusting the needle to its most sensitive position. The author considers the phasemeter particularly suitable for the measurement of low power-factors, *e.g.*, choking coils, the activity of the circuit being proportional to $C_1^2 - C_2^2$. Of the two methods employed, the first consists in shunting the e.m.f. coil across the circuit to measure the e.m.f., the coil M measuring the current. In the second method an exploring coil similar to the magnetising coil is wound on the magnetic circuit. The e.m.f. coil is connected in series with the exploring coil, and the current coil in series with the magnetising coil. The author finds that the value of the hysteresis watts by method II. is much more consistent than by method I., this being particularly true for large air-gaps, since in the latter case the C^2R loss is large compared with the hysteresis watts.

In both the above methods the experiments were performed with an iron anchor-ring split in halves and wound with magnetising and exploring coils. The paper concludes with a detailed list of experimental results with the corresponding curves. E. S. A. R.

739. *Differential Magnetometers free from Magnetic Disturbances.* **H. du Bois.** (Ann. d. Physik, 9. 4. pp. 938–945, Nov., 1902.)—The author discusses the chief difficulties encountered in constructing magnetometers analogous to the d'Arsonval galvanometer. In the case of magnetometric measurements there are two fields of force to consider: (1) the field under test and which varies from point to point in a simple manner; and (2) the disturbing field which varies unevenly at different points and may be also subject to aperiodic fluctuations. If the latter field, however, is at a comparatively great distance from the magnetometer, the general effect will be that of a uniform horizontal field. Two magnetometers will be required, one to be placed outside the range of action of the field to be measured, and which, consequently, will register the fluctuations in the disturbing field while the other magnetometer measures the total field intensity—the difference between the two readings being proportional to the field under measurement. With regard to the magnetic needles, the author favours Stefan's astatic arrangement, the lower needle being slightly stronger than the upper one, but by adjustment of an iron ring round the latter the external or disturbing field is so weakened that the effect is just equal to that of the unweakened field on the upper needle. A mathematical treatment is given for the position of maximum horizontal strength of the field under test. E. S. A. R.

740. *Compensation Magnetometer.* **M. Corsepius.** (Elektrotechn. Zeitschr. 23. pp. 1005–1006, Nov. 13, 1902.)—The needle consists of a ⊓-shaped astatic pair of magnets moving in a horizontal plane. The magnets are joined across rigidly by a bar to which a bifilar suspension is fixed, and the readings are taken by the null method with a pointer or with a lamp and scale. The ends of the outer magnet swing freely inside small magnetising coils, one of which is connected to the "test" circuit and the other to the balancing or compensating circuit. In the "test" circuit is a rectangular iron car containing two bars of the iron to be tested and wound with primary and secondary coils. The balancing circuit has a permanent rectangular coil wound with primary and secondary coils, the secondary being in connection with a current divider, and also with one of the needle coils. The number of ampere-turns and the cross-section of the two primary coils are so arranged that, on adjustment of the needle to the zero position, the value of B is read off directly. The author claims cheapness, accuracy, and rapidity of working for the instrument. E. S. A. R.

ALTERNATING CURRENTS AND MAGNETISM.

741. *Errors in the Magnetometric Method.* **T. Erhard.** (Ann. d. Physik, 9. 3. pp. 724–726, Oct., 1902.)—The commonest way of testing samples of iron is to magnetise a sample by a coil, say, to the East of a magnetometer, the coil being compensated by another coil, say, to the West. The general supposition made is that the direct action of the magnetising currents on the needle is in this way cut out. The author quotes results of his in which he varies his magnetic field from 0·9 to 128·0 c.g.s., and even higher; he finds the field at the position of the needle changes by as much as 8 per cent. of the original field. He suggests that for magnetometer one should use a single mirror galvanometer, and that through its coil the compensating current should be sent. P. E. S.

742. *Inductive Magnetic Resistance.* **J. Zenneck.** (Ann. d. Physik, 9. 3. pp. 497–521, Oct., 1902.)—The author investigated a variety of problems by developing the idea of magnetic inductance, which he generally terms inductive magnetic resistance. Suppose we have a primary coil and secondary coil on an iron ring of magnetic resistance w_m. Let the current and number of turns in the primary be i_1 and N_1, and in the secondary be i_2 and N_2, and let the induction flow in the magnetic circuit be Q, then (V being a constant), $Qw_m = N_1 i_1/V + N_2 i_2/V$, but since $i_2 w_2 = -N_2/V \cdot dQ/dt$ then writing $p_m = N_2^2/w_2 \cdot 1/V^2$, we have $Qw_m = M - p_m\, dQ/dt$. W_m is termed ohmic magnetic resistance, M is the magneto-motive force, and p_m is the self-induction coefficient. For alternating currents of sine-form, we have expressions of the well-known type—

$$Q = \frac{M}{\sqrt{w_m^2 + (\pi n p_m)^2}} \cdot \sin(\pi n t - \delta), \quad \tan\delta = \frac{\pi n p_m}{w_m}.$$

The investigation is given for a variety of cases. The author arrives at the result that closed coils, metal tubes (thick or thin), rods or discs behave in a changing magnetic field along their axis as if their magnetic resistance were increased. This apparent increase of magnetic resistance for closed coils and metal tubes tends to approach to the other term, the ohmic magnetic resistance, which is constant; but for massive cylinders and discs the ohmic resistance itself apparently also increased Finally, several practical applications are given: (1) Leakage in a transformer; (2) Magnetic screening; (3) Diminution in leakage through copper plates; (4) The spreading of magnetic waves in an iron cylinder. P. E. S.

REFERENCES.

743. *Vacuum-Tube Illumination Phenomena.* **J. Borgmann.** (Phys. Zeitschr. 3. pp. 565–569, Sept. 15, 1902. From the Physikalischen-Institut der Universität, St. Petersburg.)—The author discusses a series of experiments on vacuum-tube phenomena in various positions with regard to two wires and an inductor-pole. [See also Abstract No. 726 (1902).] A. D.

744. *Röntgen-Ray Tube with Adjustment for Varying the Penetrability of the Rays.* **F. Dessauer.** (Deutsch. Phys. Gesell., Verh. 4. 13. pp. 321–322, Sept. 25, 1902. Paper read before the 74 Naturforscherversammlung at Carlsbad.)—An illustration shows the general arrangement of the tube. The antikathode is placed in a tube which has a metallic coating. This antikathode forms also one terminal of a variable spark-gap, the anode forming the other terminal. The penetrability of the rays is altered by varying the length of the spark-gap. J. B. H.

745. *Demonstrations of Electric Vibrations.* **L. Zehnder.** (Ann. d. Physik, 9. 4. pp. 899–918, Nov., 1902.)—An elaborate description of experiments suitable for illustrating a popular lecture on the subject of electric vibrations and waves. E. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

746. *Atomic Weight of Antimonium.* **E. Cohen** and **T. Strengers.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 632–640, Feb. 28, 1903.)—In connection with a physico-chemical study on the nature of the so-called explosive antimonium, the authors were lead to ascertain the true value of the atomic weight of antimonium. Though many experimenters have tried to determine this constant, it is not yet known with sufficient certainty. Repeating and extending Popper's experiments, the authors find the atomic weight, as derived from the electrolysis of antimonium trichloride solutions, to increase with the concentration of the latter, varying between 120·87 and 121·89 for concentrations ranging from 2·2 to 83·3 per cent. This fact clearly shows that the method used by Popper is not capable of giving the true value of the atomic weight, the values given by Popper being quite accidental. It further results from the above that some unknown electrolytic or chemical reactions must play a part in these phenomena, these reactions being well worthy of further investigation, on account of their bearing on the knowledge of the formation and composition of the remarkable body called explosive antimonium. The authors hope to give further attention to these phenomena.

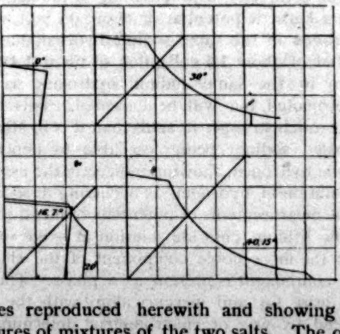
A. G.

747. *Sodium Alloys.* **M. Sack.** (Zeitschr. Anorg. Chem. 34. 3. pp. 286–353, March 18, 1903.)—Lead and tin kathodes being kathodically polarised in sodium hydroxide, the author states that the strong evolution of hydrogen occurring at these kathodes is connected with a loosening of the kathode material, due to an intermediary formation of sodide at the kathode. It is next stated that the kathodic projection of lead and tin is due to an intense polarisation, allowing of a sodium alloy of the kathode material, very rich in sodium and rather ignoble, being formed, exhibiting the property of giving rise to projection when coming into contact with water. The brisk evolution of hydrogen connected with loosening of the kathode takes place in the case of lead at a kathode potential of about 0·7 volt, with tin at 0·4 volt, with regard to hydrogen in the same sodium hydroxide as zero; projection of lead, at a potential of about 1·5 volts, that of tin at 1·4 volts, equally with regard to hydrogen in the same sodium hydroxide as zero. Zinc and platinum are not projected, but will be loosened. This loosening of both platinum and lead is much stronger in acids than it is in alkali, this fact being due to the discharged sodium being less able to penetrate the kathode metal than the mobile hydrogen, showing indirectly the essentially secondary character of the evolution of hydrogen as occurring in sodium hydroxide on these kathodes. The measurements of potentials of metal-sodium compounds in a methyl alcoholic lithium chloride solution at —80° show all the peculiarity that layers of the more noble component of the alloy will be formed, whenever the noble component is present as a phase. They therefore allow of the presence of lead, tin, and mercury along with the sodides of these metals being detected by way of electrometric determinations. The rule that with any combination of solid bodies with solid bodies to form solid bodies, the evolution of heat will be equivalent to the free energy, is confirmed, as the values of the sodide potentials, as calculated from the amount of heat evolved and the sodium potential in methyl alcoholic lithium-chloride solution, agree fairly well with the experimental values. A. G.

748. *Artificial Preparation of Kaliborite.* **J. H. van't Hoff.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 42. pp. 1008–1012, Oct. 30, 1902.) — Kaliborite occurs in the Stassfurt salt-beds along with pinnoite, MgB_2O_4, $8H_2O$, and kainite K_2SO_4, $MgSO_4$, $6H_2O$. It can be prepared by digesting pinnoite with a solution having the composition $1{,}000H_2O$, $9\frac{1}{2}K_2Cl_2$, $47MgCl_2$. It may be prepared in quantity by making magnesium borate octahydrate from borax and magnesium chloride, heating with magnesium chloride at 100° in a porcelain dish to dehydrate the octahydrate, sodium chloride being added from time to time until the pinnoite begins to separate; potassium chloride is then added, and within twenty-four hours the kaliborite crystallises from the solution. It can also be prepared from a solution containing no sodium, and when analysed gave H_2O 24·5, MgO 11·7, K_2O 6·7, B_2O 57·1 per cent., agreeing with the formula $KMg_2B_{11}O_{19}$, $9H_2O$. T. M. L.

749. *Colloidal Metals.* **J. Billitzer.** (Phys. Zeitschr. 4. 1b. pp. 41–42; Discussion, pp. 42–43, Oct. 10, 1902. Paper read before the 74 Naturforscherversammlung at Carlsbad.)—Colloidal platinum, the particles of which can act either as an oxygen or as a hydrogen electrode, is not precipitated by reducing non-electrolytes such as alcohol, but is precipitated by indifferent electrolytes which are neither acids nor bases; these results are put forward as contrary to Bredig's theory ("Inorganic Ferments," Leipzig, 1901). Barium chloride added to a suspension of porcelain becomes acid, and the solution loses barium though retaining a normal proportion of chlorine; if marble is used in place of porcelain it becomes alkaline and chlorine is absorbed, the amount of barium in the solution being unchanged. The porcelain takes up a negative charge and the marble a positive charge. T. M. L.

750. *Formation and Solubility of Sodium Copper Sulphate.* **J. Koppel.** (Zeitschr. Phys. Chem. 42. pp. 1–16, Oct., 1902.) — The compound $CuSO_4$, Na_2SO_4, $2H_2O$ is only stable above 16·7°, the constituent sulphates crystallising separately below that temperature. This is clearly shown by the five curves reproduced herewith and showing the solubility at different temperatures of mixtures of the two salts. The ordinates represent mols. $CuSO_4$ and the abscissæ mols. Na_2SO_4 per 100 mols. H_2O in the saturated solution. The double salt is identical with the mineral Kröhnkte. T. M. L.



751. *Atmospheric Hydrogen.* **A. Leduc.** (Comptes Rendus, 135. pp. 860–861, Nov. 17, 1902.)—The author had previously determined, in weight, the mass of oxygen in 1 gramme of air after treatment with potash and drying agents, and had found that at Paris it amounted to 0·2818 to 0·2823 O, with an error not exceeding $\frac{1}{10000}$. Calculating from the equation $xd+(1-x)d'=1$, where d and d' are the densities of O and N, and x the content of air in oxygen, it results that $xd=0{\cdot}2822$ (as a maximum), agreeing with the mass found above. If, however, there were as much hydrogen in the atmosphere as Gautier asserted, namely 1 cc. in 5 litres, taking ϵ as its proportion in volume and d'' as its density, the equation of mass becomes—

$$xd+(1-x-\epsilon)d'+\epsilon d''=1,$$

whence $xd=0{\cdot}2836$—a result far from the truth. The author therefore confirms with Rayleigh's conclusion [see Abstract No. 1754 (1902)] that the proportion of free hydrogen in country air is at least six or eight times less than Gautier alleged. Leduc has found, incidentally, that the air of London is a little less rich in oxygen than the air of Paris. S. R.

752. *Liquid Sulphur Dioxide as a Solvent.* **P. Walden** and **M. Centnerszwer.** (Zeitschr. Anorg. Chem. 30. 2. pp. 145–251, 1902.)—The object of this extensive paper is to investigate the behaviour of solutions of solid substances (electrolytes) in liquid sulphur dioxide, in order to arrive at a thorough knowledge of the analogies and discrepancies exhibited by this new solvent as compared with water; it forms a part of a series of experimental researches initiated three years ago. In the choice of this solvent the authors have been guided by the fact that the two solvents and ionisers hitherto known, *i.e.*, water and liquid ammonia, are both compounds of one "acidogeneous" and one "basogeneous" element respectively, whereas sulphur dioxide is composed of two "acidogeneous" elements. After a very full account of experiments they summarise the results of this (their most interesting) work in the following conclusions: (1) The conductivity of purest sulphur dioxide in the liquid state comes very near that shown by liquid water and liquid ammonia; by analogy with these two solvents this conductivity may be ascribed to electrolytic decomposition into $\overset{++}{\mathrm{SO}}+\overset{--}{\mathrm{O}}$ or $\overset{++++}{\mathrm{S}}+2\overset{--}{\mathrm{O}}$. (2) Liquid sulphur dioxide is a solvent for many (binary) inorganic salts and most salts of inorganic bases, as for several classes of organic bodies, solution being often accompanied by striking changes of colour. (3) Liquid sulphur dioxide solutions of salts are good conductors of electric current, many of them possessing a conductivity exceeding that of the corresponding aqueous solutions at the same temperature and concentration, while in some other cases it is greatly inferior. (4) Most of the simple laws governing the conductivity of aqueous salt solutions do not apply to sulphur dioxide solutions: neither the law of independent migration of ions nor the law that with increase of dilution molecular conductivity will tend towards a limit, nor the rule that for all (binary) salts the rise of conductivity with dilution will be identical, nor finally Ostwald's dilution law. On the other hand, both Rudolphi's and van't Hoff's formulæ are found to agree fairly well with experiments, except for bad electrolytes. Stœchiometrical relations between the values of conductivity are partly analogous to those established for aqueous solutions, but with a few striking differences in behaviour. (5) Some salts will be able to give complex compounds, as is shown both by increase of solubility and by conductivity measurements; in opposition to aqueous solutions, these complex

compounds exhibit a conductivity superior to that of the mother-substances. (6) Investigations on dependence of conductivity upon temperature, as carried on over an interval of temperature ranging from the melting-point to the critical point of sulphur dioxide, show that molecular conductivity of salts will at first increase with temperature, arrive at a maximum at a definite temperature, dependent on the nature and concentration of the salt in solution, then fall, and finally disappear at the critical temperature. From a discussion of the details of the results it is suggested that the behaviour which is exceptional in the case of aqueous solutions is here the normal one; the variation of the temperature coefficient with temperature, concentration and—last, not least—the nature of the salt, the existence of a maximum conductivity and the preponderance of negative temperature coefficients, it being argued from the latter circumstance that neutral salts on being dissociated into ions in liquid sulphur dioxide will give rise to an evolution of heat. (7) From the disappearance of conductivity at the critical point, as shown by experiments made at high temperatures—in spite of the electrolytes remaining in solution above this point—the author arrives at the conclusion that electric conductivity and electrolytic dissociation in solutions are properties inherent to the liquid state. (8) The question next arising from this fact, as to which factors form the necessary and sufficient conditions of ionisation, the author answers by pointing out the important *rôle* of surface tension, this constant—as measured by the number of molecules raised—determining directly the dissociative power of the solvent, though other factors, as the dielectric constant (Thompson and Nernst), the presence in the solvent of unsaturated valencies (Brühl), and the degree of association (Crompton, Dutoit), should not be neglected. The intimate relation between surface tension and conductivity is clearly shown by both quantities vanishing at the critical temperature and by the fact established by the author that out of the number of investigated solvents those possessing a remarkable ionisation power all exhibit a great surface tension. This does not, however, mean proportionality of both constants, as their dependence on temperature and nature of the electrolyte in solution is different. (9) The molecular elevation of the boiling-point of liquid sulphur dioxide has been calculated, the result (15·0) being confirmed by molecular weight determinations on several non-electrolytes. From this the conclusion is drawn that non-electrolytes have a normal behaviour in liquid sulphur dioxide, *i.e.*, exhibit normal molecular qualities. (10) On the other hand electrolytes (salts) exhibit—in opposition both to theory and prevision—too high molecular weights, in most of the cases higher than normal ones, the theory requiring for dissociated bodies molecular weights smaller than normal, in accordance with their decomposition. The author shows that (1) the number of molecules formed by one molecule of the salt in solution (i) will increase with dilution for those salts which possess molecular weights greater than normal ones, while it decreases for those apparently satisfying the demands of the dissociation theory, in both groups of salts tending towards the value 1; (2) those salts possessing higher conductivity exhibit greater values of i and *vice-versâ*. (11) In order to account for these disagreements with theory it is assumed that in addition to the electrolytic dissociation there takes place a (non-electrolytic) association of the solutions of liquid dioxides, this hypothesis explaining on the other hand the non-validity of the dilution law. It is next suggested that this association occurs (*a*) between the molecules of the salt (polymerisation), (*b*) with the intervention of the solvent, several salt molecules combining with one or more molecules of the solvent to form a complex molecule able to send off ions (either directly or after decomposition). This

hypothesis not only best agrees with current views on the constitution of solutions, but appears to represent most satisfactorily both the chemical character of the solvent and its physical properties. (12) The phenomena observed in liquid sulphur dioxide appear to represent the prototype of the behaviour of electrolytes in non-aqueous solutions. [See also Abstract No. 910 (1902).]
A. G.

753. *A Numerical Example of the Newer Theory of Solutions.* **J. B. Goebel.** (Zeitschr. Phys. Chem. 42. pp. 59–67, Oct., 1902.)—In the case of a binary electrolyte having a dissociation-constant K, it is necessary to take into account also (1) The mutual influence of the neutral molecules, expressed by a coefficient a_1. (2) The mutual influence of the ions, $a_2 + a_{23}$. (3) The influence of ions and non-electrolyte upon one another, a_{12}. In the case of sodium and potassium chloride data are available for calculating these quantities and the following values are given ($m_0 =$ mol. wt. of solvent).

	$\frac{m_0}{1,000} a_{12}$	$\frac{m_0}{1,000} \frac{a_2 + a_{23}}{2}$	$\frac{m_0}{1,000} \cdot \frac{1}{K}$
NaCl	8·28	1·865	8·46
KCl	6·00	8·25	15·84

In each case the value of a_1 is probably negligible, and (as might have been expected) the introduction of the two arbitrary constants a_{12} and $(a_2 + a_{23})$ allows of a very exact calculation of the dissociation isotherms.
T. M. L.

754. *Nature of Metastable State.* **F. W. Küster.** (Zeitschr. Anorg. Chem. 33. 3. pp. 363–369, Jan. 5, 1903.)—Such supersaturated solutions as under certain conditions may be conserved for an apparently unlimited time, without the phase in question separating (provided all germs of this phase be excluded), are termed *metastable* by Ostwald. Now a definite delimitation between these solutions and the so-called unstable ones—where the phase concerned is finally separated in a spontaneous way—seems not to be possible. The author, therefore, suggests defining the metastable state in a somewhat different manner. It is known that the solubility of solid bodies depends on the degree of division of the same; that is to say, it will increase as the body is more finely pulverised. These differences become more marked when the diameter of the particles is less than about 2 μ. Now, the author applies the term "*primitive crystals*" to the ultimate particles existing as crystals, these particles being made up of a limited number of molecules. Very complex "primitive crystals" might approach very closely the dimensions of the finest powders tested as to their solubility. The maximum solubility, *i.e.*, the "solubility of primitive crystals," will be reached, as the whole of the substance is converted into such primitive crystals. Destroying the latter by further division, the solubility, it is true, will still be found to increase, but the body will be different from what it was before, having lost its crystalline structure. The region of "metastable" solutions is bounded on one side by ordinary solubility, *i.e.*, solubility of greater crystals; on the other, by the solubility of primitive crystals. Metastable solutions are therefore saturated with regard to greater crystals (which will grow in them), but unsaturated as to primitive crystals (which will disappear in them). Now, as the first product of crystallisation must be a primitive crystal, spontaneous crystallisation will be impossible in a solution like this, whereas introduced crystal fragments of sufficient dimensions will grow on, changing the solution into a stable saturated one. This delimitation, however, though theoretically speaking very accurate, does not afford any precise definition in practice, as the concentration is never the same at all points of a solution, which, though being saturated on the average with regard to primitive crystals, may be supersaturated at an infinite number of points with regard to the same, the primitive crystals formed there thus going on growing; in such a solution, spontaneous crystallisation will therefore occur. On the other hand, such bodies as possess the most complicated primitive crystals, are most likely to give metastable solutions. This conclusion seems to be borne out by experiment, as bodies of a simple crystalline structure, such as sodium chloride, have little capacity for forming supersaturated solutions, whereas all the substances of which stable supersaturated solutions are known, exhibit a complicated crystalline structure, including mostly crystal water. It, however, seems desirable to test this possible relation by special experiments. A. G.

755. *Velocity of Transformation of Tribromphenol-Bromine into Tetrabromphenol.* **A. H. J. Belzer.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 627–632, Feb. 28, 1903.)—The author undertakes to investigate the velocity of transformation of tribromphenol-bromine into its isomeric. The fact that the former body will easily part with one Br-atom, suggested the possibility of its quantitative determination, during the formation of tetrabromphenol. In the beginning of the research, the ratio of the solid with regard to sulphuric acid has been tested. Pouring concentrated acid on the crystals, these are found to lose their yellow colour, without, however, a solution in the acid being observed. If the velocity of reaction be measured under these circumstances, no reaction constant is found to exist, the reaction coefficient decreasing continually, on account of the increasing difficulty the acid meets with in invading the internal parts of the crystal. If, however, the tests were made in a solvent, reaction constants would be found to exist when applying the formula of the first order; the reaction is thus not a bimolecular one, as stated by previous experimentors. It is further inferred from the results obtained that the reaction has to be considered as an intramolecular transposition of atoms. A. G.

756. *Bipolar Electrodes.* **A. Brochet and C. L. Barillet.** (Comptes Rendus, 135. pp. 854–857, Nov. 17, 1902.)—The authors have tested the effect of placing a loosely fitting sheet of platinum, which they call the interelectrode, between the electrodes in an electrolytic cell; the side of the interelectrode facing the anode they call the interkathode, that facing the kathode the interanode. A solution of copper sulphate was employed for the electrolysis, and it was found that below a certain current density no copper was deposited on the interelectrode, which acted merely as a non-conducting sheet and increased the resistance of the cell. When the current density increases above a certain value, corresponding in all cases with a difference of potential at the electrodes greater than the decomposition potential of copper sulphate, a certain amount of electricity passes through the electrode, copper being deposited in a circle on the interkathode and gas evolved at the interanode. On increasing the area of the platinum interelectrode, the deposit of copper and the difference of potential at the electrodes are, for the same current density, increased. At the best, however, the amount of electricity which passes through the electrode is always very small, the amount of copper deposited on the interelectrode never being greater than 2·5 per cent. of the total amount deposited. With two interelectrodes, the potential is greater and the deposit of copper on them less than with one interelectrode. The potential at the electrodes is diminished by shifting the interelectrode towards either the anode or the kathode; if the current is maintained constant, the area of the deposit on the interelectrode increases, but its thickness diminishes on placing the interelectrode nearer to the anode, while the opposite behaviour is shown on approaching it to the kathode. If the interanode has been previously coated with a deposit of copper, it acts as a soluble electrode, and a deposit is formed on the interkathode; when the copper on the interanode has entirely disappeared, the potential suddenly increases and the deposit on the interkathode gradually dissolves at the edges, leaving a circle of copper which is, however, greater than that obtained by direct deposition. A. F.

757. *Electrolytic Preparation of Tetraalkylated Diamidobenzhydrols.* **F. Escherich** and **M. Moest.** (Zeitschr. Elektrochem. 8. pp. 849–851, Nov. 6, 1902.)—By the electrolysis of tetramethyldiamidobenzophenone in sulphuric acid solution, the authors have obtained the corresponding hydrol and pinacone; and, by the electrolytic oxidation of tetramethyldiamidodiphenylmethane have also obtained the same hydrol, which is not oxidised by the anodic oxygen. The relative amounts of hydrol and pinacone obtained in the former process vary with the electrodes employed, hydrol being almost the only product when lead electrodes are employed. The strength of acid employed has also a certain but smaller influence. For the reduction of tetramethyldiamidobenzophenone a current of 7 amperes was employed at the commencement, and this was then gradually reduced to 3 amperes, the potential being 3·5–3·2 volts and the current density 0·7 amperes per sq. dcm. No diaphragm was used. Yield 91 per cent. For the preparation of the pinacone copper electrodes were used, and the current density was 1·5 amperes per sq. dcm. A yield of 75 per cent. was obtained. For the oxidation of tetramethyldiamidodiphenylmethane the latter was electrolysed in only feebly acid solution. The electrodes were of lead, and the current density was about 1 ampere per sq. dcm. When a mixture of tetramethyldiamidobenzophenone and tetramethyldiamidodiphenylmethane in sulphuric acid solution was electrolysed no gas was evolved until the theoretical amount of electricity had passed, when bubbles of gas were then observed. The electrodes were of lead, the potential was 3–4 volt, and the current density 1–2 amperes per sq. dcm. A. F.

758. *Electrochemical Reduction of Ketones.* **K. Elbs** and **K. Brand.** (Zeitschr. Elektrochem. 8. pp. 783–788, Oct. 9, 1902.)—The authors have examined the electrochemical reduction of ketones (in presence of ordinary alcohol where necessary) between lead electrodes, in alkaline and also in sulphuric acid solution. In both cases acetone, methyl ethyl ketone, acetophenone, benzophenone, phenyl *p*-tolyl ketone, phenyl *m*-xylyl ketone, phenyl *a*-naphthyl ketone, and *p*-oxybenzophenone were examined; in alkaline solution alone, *p*-oxybenzophenone benzoate, tetramethyl *p*-diaminobenzophenone and dibenzyl ketone, and in acid solution alone, *p*-ethoxybenzophenone and phthalyl *p*-aminobenzophenone. In the experiments a diaphragm was found necessary for a good yield; the lead kathode was prepared according to Tafel's directions (Ber. 33, 2209–2224). The authors summarise their results as follows: (1) The reduction in alkaline solution gives the same products as chemical reduction with sodium amalgam or zinc dust and alkali; the electrochemical method is suitable in many

instances for the preparation of benzhydrols. (2) Reduction in acid solution gives pinakones, but if the latter are sensitive to acids we get in their place the corresponding α- or β-pinakolines. The method is therefore not so generally applicable to the preparation of aromatic pinakones as that of Elbs and Schmitz (reduction by zinc and acetic acid). Both fatty and aromatic ketones are reduced, but in the case of fatty and fatty-aromatic ketones we have secondary alcohols and pinakones produced together, while from purely aromatic ketones we obtain pinakones alone. D. H. J.

759. *Electrochemical Reduction of Ortho- and of Para-nitrobenzene Sulphonate in Alkaline Solution.* **K. Elbs** and **T. Wohlfahrt.** (Zeitschr. Elektrochem. 8. pp. 789–791, Oct. 9, 1902.)—Reduction of *p*-nitrobenzene sulphonate gives azobenzene *p*-disulphonate in nearly quantitative yield, and on further reduction we get the corresponding hydrazo compound. For the preparation of the azo body an anode of lead was placed in a moderately strong solution of potassium carbonate contained in an earthenware pot; the kathode was a nickel gauze cylinder of 200 sq. cm. area. A glass beaker served as the cell and the kathode liquid was a solution of 15 grammes of *p*-nitrobenzene sulphonate of potassium dissolved in 150 cc. of hot water. A kathode current density of 6 to 8 amperes per 100 sq. cm. gives the best results. The product crystallises out on cooling. The further reduction to the hydrazo compound occurs in more concentrated solution and with a current density of only 2 to 3 amperes per 100 sq. cm., and finally (during the last hour of the operation) of 0·5 to 1 ampere; the yield of the hydrazo compound is very good. The *o*-nitrobenzene potassium sulphonate when examined in the same way as the para salt behaves in an anomalous way; only to a small extent do we get normal reduction to the azo compound while the chief products are complex bodies and *o*-amino-sulphonic acid. D. H. J.

760. *Electrolytic Reduction of m-Nitrophenol in Alkaline and in Acid Solution.* **E. Klappert.** (Zeitschr. Elektrochem. 8. pp. 791–792, Oct. 9, 1902.)—So far no metanitrophenol has been examined to see whether this class of bodies conforms to the rules set up by Elbs for mono-nitro derivatives generally. The author finds that *m*-nitrophenol in alkaline solution gives *m*-azophenol, and thus answers expectations. It is important to conduct the reduction rapidly in the hot, to employ just the quantity of current theoretically necessary for the formation of the azo compound and to precipitate the product at once by addition of acid. In sulphuric acid solution *m*-amino-phenol-sulphonic acid is the electrolytic product. D. H. J.

761. *Hydrogen Peroxide.* **K. Bornemann.** (Zeitschr. Anorg. Chem. 34. 1. pp. 1–43, Feb. 5, 1903.)—The author states that a platinum electrode charged with oxygen will exert on the formation, and to a still higher degree on the destruction, of H_2O_2, a catalytic effect far greater than electrodes free from oxygen. When eliminating the oxygen progressively by kathodic polarisation, the catalytic power of platinum therefore diminishes in degree. On such platinum, prepared by kathodic polarisation, it proved easy to obtain kathodic formation of H_2O_2 in quantitative amounts, electrolysis being carried out from a voltage 0 as far as $-0·77$ (as measured with respect to the $H_2-\text{electrode}=0$). Between $-0·77$ and $-1·08$, similar conditions are

likely to prevail, the highest obtainable H_2O_2-concentration decreasing, however, continually, so as to become insensible for oxygen potentials. The oxidising body, as noted by Wilsmore in the electrolyte of an oxygen electrode, was again detected, and turned out not to be hydrogen peroxide. The author considers himself warranted in presuming an intermediary complete formation of H_2O_2 in the whole interval of voltages from 0 to —1·08, that is to say, a formation of H_2O_2, however small, may occur, as soon as the hydrogen has exceeded the equilibrium pressure existing between O_2 at 1 atmosphere and H_2O.

In the oxygen-hydrogen catalysis by platinum, traces of H_2O_2 were detected, under convenient circumstances, affording an instance of intermediate formation of H_2O_2. Unlike oxygen, hydrogen thus behaves as a gas in a manner perfectly analogous to its behaviour in the electrolytic nascent state. On account of the intermediate formation of H_2O_2, as well as of a determination of the oxidation energy of H_2O_2 made by Haber, the author was able to carry out a complete study of the equilibrium phenomena of the system $H_2 + O_2$, account being taken of the two known compounds of these components. In accord with Luther and Haber's results, for H_2O_2 there were obtained the following characteristic potentials: —0·8 and —1·4. The knowledge of the equilibrium conditions, however, does not suffice to account fully for the chemical and electrochemical behaviour of hydrogen peroxide; velocity phenomena have also to be considered. By doing so, the author is able to give an explanation of the impossibility of an anodic formation of H_2O_2, as well as of the conditions noted with direct measurements of the potential of an H_2O_2-solution. A. G.

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762. *Structure of Metals and Binary Alloys.* **W. Campbell.** (Frank. Inst., Journ. **154**. pp. 1–16, July; 131–142, Aug.; and pp. **201–223**, Sept., **1902**. Paper read at the Stated Meeting, held Dec. 11, **1901**.)—A summary is given of the methods used in determining by microscopic examination the structure of metals and alloys. An account is given of results obtained with the simple metals and with binary alloys of tin with lead, zinc, antimony, nickel, arsenic, phosphorus, and bismuth, of antimony with lead and copper, of aluminium with zinc and antimony, of silver with lead, tin, and antimony, and finally of the copper-tin alloys studied by Stead and by Heycock and Neville [see Abstract No. **1382** (**1902**)]. T. M. L.

763. *Gas Analysis by Measurement in Constant Volume under Changing Pressure.* **T. W. Richards**. (Amer. Acad., Proc. **38**. **5**. pp. **273–279**, Oct., **1902**.)—A description and figure of a simplified apparatus carrying out Hempel's method with a smaller quantity of mercury, and capable of yielding results sufficiently accurate for many ordinary purposes. S. R.

764. *Vapour-Pressure in the System: Water, Acetone, and Phenol.* **F. A. H. Schreinemakers.** (Zeitschr. Phys. Chem **39**. pp. **485–510**, Jan. **17**; **40**. pp. **440–464**, April **15**, and **41**. pp. **331–345**, July **25**, **1902**.)—The author has previously discussed the various possible cases that may occur in studying the vapour-pressure of ternary mixtures, and the present papers contain an account of an experimental study of one of these cases. [See also Abstract No. **443** (**1903**).] T. M. L.

765. *On the Solution of Problems in Crystallography by Means of Graphical Methods, based upon Spherical and Plane Trigonometry.* **S. L. Penfield.** (Amer. Journ. Sci. **14**. pp. **249–284**, Oct., **1902**.)

766. *Conductivity of Mixtures of Electrolytes.* **B. Sabat.** (Zeitschr. Phys. Chem. 41. pp. 224–231, July 8, 1902. Doktorats dissertation.)—Measurements were made of the conductivity of mixtures of $HCl + HNO_3$, $HCl + HSO_4$, $HNO_3 + H_2SO_4$, and of $HCl + HNO_3 + H_2SO_4$. Values were also calculated by means of a formula given by Barmwater, but the agreement was not satisfactory. T. M. L.

767. *Ionic Energy of Gaseous Elements, the Metallic State, and the Algebraic Sign of Electrolytic Dissociation.* **J. Stark.** (Phys. Zeitschr. 3. pp. 403–406, June 15, 1902.)—The paper gives a short account of the theory of ionisation by ion collisions, and points out the importance of this for the study of the energetics of chemical atoms. [See also Abstract No. 1378 (1902).] A. F.

768. *Catalytic Lecture Experiments.* **A. A. Noyes** and **G. V. Sammet.** (Zeitschr. Phys. Chem. 41. pp. 11–27, June, 1902. The lectures were delivered before the North-Eastern Section of the American Chemical Society and the Society of Arts of the Mass. Institute of Technology.)—The authors give details for the arrangement of 21 simply prepared lecture experiments to illustrate the seven following classes of catalysers :—(1) Carriers, (2) absorbent contact substances, (3) electrolytic contact bodies, (4) water, (5) dissolved electrolytes, (6) enzymes, (7) inorganic colloids. The experiments chosen are all well known. D. H. J.

769. "*Sickening*" (*loss of strength*) *of Iron and Copper.* **E. Heyn.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1115–1123, July 26, 1902. Communicated by the Kgl. Mechanisch-Technischen Versuchsanstalt at Charlottenburg. Paper read before the Berliner Bezirksverein, March 20, 1902.)—This is a very extensive paper, having regard to the thermal treatment of iron and copper in connection with the resulting reduction in their tensile strength. O. J. S.

770. *Behaviour of Diaphragms in Electrolysis of Aqueous Solutions.* **W. Hittorf.** (Zeitschr. Elektrochem. 8. pp. 481–482 ; Discussion, pp. 482–484, July 24, 1902. Paper read before the German Electrochemical Society at Würzburg, May 9, 1902.)—A paper on the same lines as that dealt with in Abstract No. 922 (1902). W. C. B.

771. *Metallic Conduction and the Constitution of Alloys.* **J. A. Mathews.** (Elect. World and Engineer, 40. pp. 531–533, Oct. 4, 1902.)

772. *Methods and Resources of Leyden Cryogen Laboratory. III.* **Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 502–511, Dec. 27, 1902.)—In this paper full particulars are given of the methods and resources in use in the Leyden Cryogen Laboratory in order to obtain baths of very equal and constant low temperatures in the cryostat. A. G.

773. *Preparation of Aluminium.* **F. Haber.** (Zeitschr. Elektrochem. 8. pp. 607–616, Aug. 21, 1902. Paper read before the German Electrochemical Society at Würzburg, May 9 and 10, 1902.)—It has been thought that the preparation of aluminium on the small scale by the electrolysis of alumina dissolved in fused cryolite, would present difficulties. The author gives details of the arrangements necessary in small operations and shows how they may serve to elucidate the phenomena which present themselves in working on the large scale. [See also Abstract No. 1165 (1902).] D. H. J.